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EXPERIMENTAL DATA FORMING THE BASIS FOR THE BOMBING TABLES BT-100-A-1 BOMB, PRACTICE, 100-LB., M39

by

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U.S. ARMY ABERDEEN RESEARCH AND DEVELOPMENT CENTER
BALLISTIC RESEARCH LABORATORIES
ABERDEEN PROVING GROUND, MARYLAND

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EXPERIMENTAL DATA FORMING THE BASIS FOR THE BOMBING TABLES

BT-100-A-1

BOMB, PRACTICE, 100-LB., M39

Range bombing was conducted for the Bomb, Practice, 100-lb., M39 from December 1, 1936 to April 29, 1937. A total of seventy ranges for nominal altitudes between 4000 feet and 15000 feet with true air speed varying between 119.6 miles per hour and 197.9 miles per hour, with the largest proportion of air speeds in the neighborhood of 160 miles per hour, was obtained. The results are summarized in Table A.

TABLE A

Bomb Program Group and Number	Date of Flight	Camera True Air Speed mi/hr	Altitude (feet) (Rounded to four figures)	C_R	Remarks
1	12-1-36	162.3	14,680	2.26	
2		162.1	14,630	1.97	
3		164.6	14,640	2.08	
4		163.2	14,670	1.83	
5		163.1	14,670	2.35	
6		159.3	14,620	1.86	
7		157.8	14,640	1.74	
8		160.7	14,640	1.05	(Not employed in 2.06. Chauvenet's Criterion)
1	12-8-36	154.3	14,790	2.18	
2		156.5	14,810	1.90	
3		160.8	14,770	2.13	
4		158.3	14,800	2.46	
5		160.2	14,770	1.60	
1	3-30-37	166.4	11,830	1.98	
2		158.1	11,750	1.93	
3		164.2	11,790	2.22	

Bomb Program Group and Number	Date of Flight	Camera True Air Speed mi/hr	Altitude (feet) (Rounded to four figures)	C_R	Remarks
4	3-30-37	165.2	11,830	1.88	
5		164.3	11,790	1.94	
1	3-30-37	160.9	11,850	1.58	(Not employed in 2.06.Chauvenet's Criterion)
2		161.6	11,900	1.84	
3		160.1	11,900	1.98	
4		161.7	11,900	2.07	
5		160.3	11,900	0.88	(Not employed in 2.06. Stated noise)
6		165.1	11,890	2.19	
6	12-8-36	140.3	11,750	--	
7		148.6	11,730	3.66	(Not employed in 2.06. Release point dubious)
8		146.7	11,740	2.11	
9		146.9	11,750	1.08	(Not employed in 2.06. Stated noise)
6	3-30-37	157.0	9,770	2.43	(Not employed in 2.06. Chauvenet's Criterion)
7		158.2	9,750	1.21	(Not employed in 2.06. Observer's opinion)
8		158.9	9,760	1.82	
9		161.3	9,780	2.08	
7	3-30-37	157.1	9,880	2.14	
8		157.0	9,930	1.90	
9		157.1	9,890	2.09	
1	4-19-37	158.4	10,140	0.67	(Not employed in 2.06. Stated noise)
2		159.5	10,150	2.06	
3		160.5	10,140	0.68	(Not employed in 2.06. Stated noise)

Bomb Program Group and Number	Date of Flight	Camera True Air Speed mi/hr	Altitude (feet) (Rounded to four figures)	C_R	Remarks
1	11-23-36	163.5	9,780	1.99	
2		164.9	9,790	2.51	(Not employed in 2.06. Chauvenet's Criterion)
3		162.9	9,770	2.02	
4		164.0	9,800	1.70	
1	4-13-37	147.9	7,040	2.64	
2		148.0	7,050	1.59	(Not employed in 2.06. Stated noise)
3		143.8	7,000	3.15	(Not employed in 2.06. Curved flight)
4		153.8	7,020	1.90	
5		155.9	7,020	2.59	
4	4-19-37	152.9	7,090	2.23	
5		153.6	7,070	1.11	(Not employed in 2.06. Stated noise)
6		154.2	7,040	2.29	
7		155.0	7,050	2.13	
8		151.8	7,080	2.12	
5	11-23-36	154.0	6,760	2.46	
6		151.4	6,770	2.01	
7		149.6	6,790	1.82	
8		154.6	6,810	>4.50	(Not employed in either mean. Greater than tabular range)
6	4-13-37	124.4	4,010	1.47	(Not employed in 2.06. Below 6000 feet)
7		124.4	3,930	2.65	(Not employed in 2.06. Below 6000 feet)
8		119.6	3,970	2.22	(Not employed in 2.06. Below 6000 feet)
9		123.4	3,950	1.98	(Not employed in 2.06. Below 6000 feet)

Bomb Program Group and Number	Date of Flight	Camera True Air Speed mi/hr	Altitude (feet) (Rounded to four figures)	C_R	Remarks
1	4-15-37	--	4,090	1.06	(Not employed in 2.06. Below 6000 feet)
1	4-29-37	120.9	4,070	4.70	(Not employed in 2.06. Below 6000 feet)
2		125.3	4,050	4.00	(Not employed in 2.06. Below 6000 feet)
3		124.6	4,110	2.65	(Not employed in 2.06. Below 6000 feet)
2	6-29-37	190.8	4,240	1.99	(Not employed in 2.06. Below 6000 feet)
3		197.9	4,350	2.07	(Not employed in 2.06. Below 6000 feet)
4		197.1	4,340	1.62	(Not employed in 2.06. Below 6000 feet)
5		197.2	4,310	2.26	(Not employed in 2.06. Below 6000 feet)
4	11-17-36	164.5	3,940	4.17	(Not employed in 2.06. Below 6000 feet)
5		164.8	3,940	>4.50	(Not employed in either mean. Greater than tabular range)
6		168.2	3,960	2.74	(Not employed in 2.06. Below 6000 feet)

The values of C_R not being obtained for Number 25, because of the loss of the release point nor for Numbers 56 and 70 because of their falling beyond the limits of the Beckman table (possessing values of C >4.50), there were sixty-eight ranges actually obtained from which values of the ballistic coefficient were inferred by Miss E. Boyle. The mean of all sixty-eight values of C is 2.08 as determined by E. S. Martin, if the possible variation of C with altitude be neglected altogether. The sixty-eight values of C were fitted to a straight line relation:

$$C = C_{(A_1 = 0)} + A_1 \left(\frac{\partial C}{\partial A_1}\right)$$ where A_1 is the altitude in feet, divided by 10,000. The constant, $C_{A_1 = 0}$, was found to have the value 2.627 and the slope was found to be -0.5747. The resulting probable error of a single observation upon C appears ± 0.458 on the somewhat incorrect basis of C being normally distributed about the line

$$C = C_{(A_1 = 0)} + A_1 \left(\frac{\partial C}{\partial A_1}\right).$$

The employment of a "T" test for significant departure of the slope from zero yields the strong probability of 0.99 that the departure is significant. Whether, of course, the departure is to be attributed to a genuine variation in C, which is to say, to a departure of the Gavre function from the actual resistance function for the bomb, as the velocity increases, or to certain other physical causes, or to observational dispersion, is not, of course, given by the "T" test. It is not improbable that a combination of several causes, including notably the difficulty of a very accurate determination of ground speed for low altitudes, has played a part in the apparent variation of C with altitude. The sloped line and probable error band on graph A indicate the nature of the computed variation in C with altitude.

The Tables BT-100-A-1 for the Bomb, Practice, 100-lb., M39, were actually constructed for a value of the ballistic coefficient, C_R, of 2.06. The value 2.06 is extremely close to the mean value 2.08 for the entire 68 bombs, but was arrived at in a somewhat different fashion as described below. It is also notable that the value 2.06 approximates the value 2.05, which is that of the least squares line for an altitude of 10,000 feet as can be seen from the graph A. The value 2.06 thus appears to be as good a value as is obtainable from the observed ranges.

The determination 2.06 was arrived at by rejection of the bombs marked "Not employed in 2.06" in Table A for the reasons given in Table A. The reasons are based partially upon the observer's opinions on the bomb flights, partially upon Chauvenet's criterion and partially upon insufficiency of data.

The values near 4000 feet were not uniform and were rejected altogether. It is evident that the choice of rejections did not modify the value of C appreciably. It may be considered not unreasonable that 0.458 is a proper estimate of the probable error in C for this bomb.

The Bombing Tables BT-100-A-1 for the Bomb, Practice, 100 lb., M39 have been computed on the basis of C = 2.06 by Miss E. Boyle. The values of the trail angle were obtained by employment of the Beckman trail curves for values of C near 2.06 and interpolation. The DS was taken to have negligible variation with Air Speed and was obtained for an Air Speed of 160 miles an hour.

F. V. Reno

BALLISTIC COEFFICIENT AS A FUNCTION OF ALTITUDE

DATES OF FLIGHT: 12-1-36, 12-8-36, 3-30-37, 12-8-36, 3-30-37, 4-19-37, 11-23-36, 4-13-37, 4-19-37, 11-23-36, 4-13-37, 4-15-37, 4-29-37, 6-29-37, 11-17-36

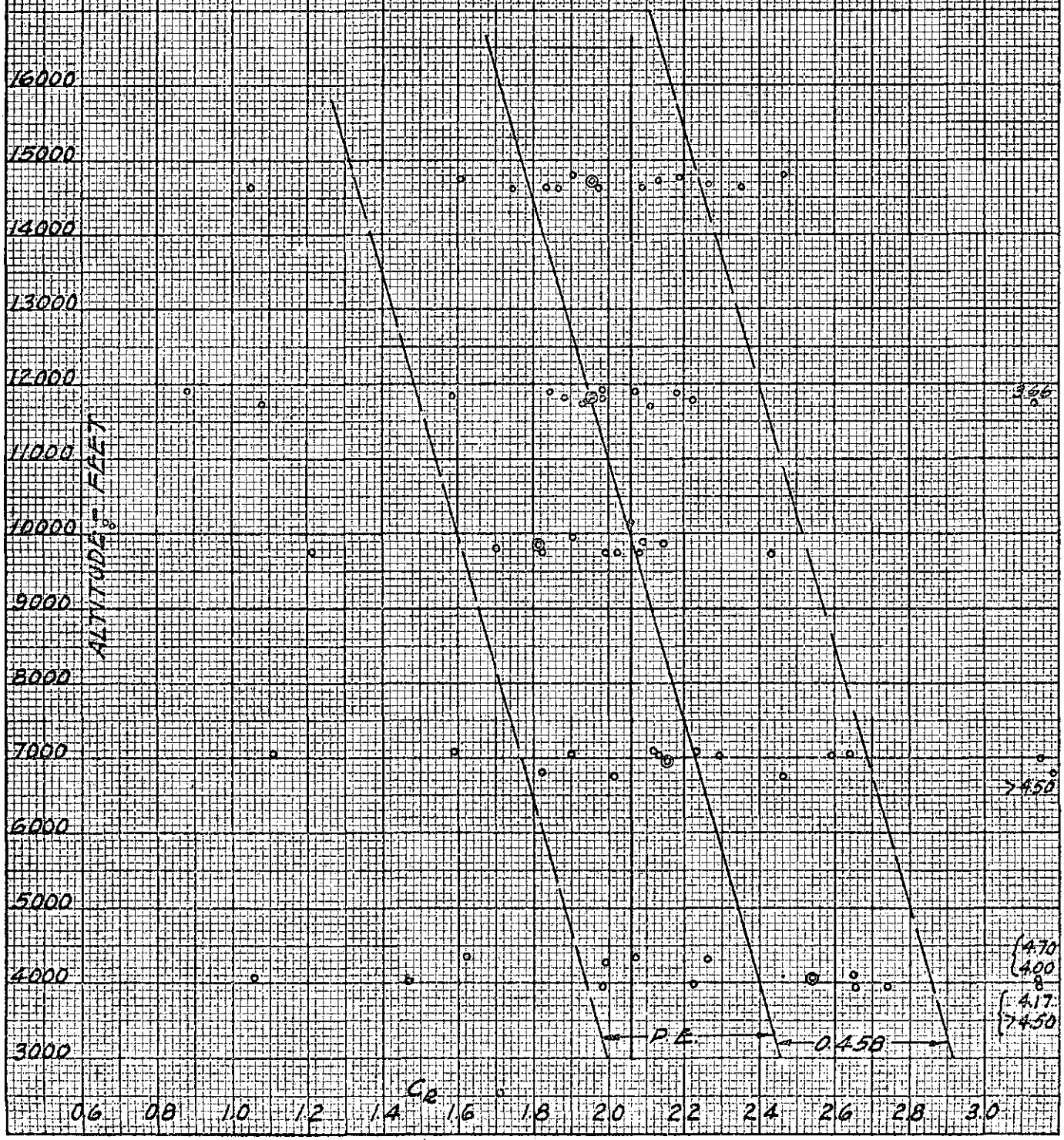
PURPOSE: EFFECT OF ALTITUDE

OBSERVERS: BROWN, ATKINSON, WILLAN

COMPUTERS: BOYLE, MARTIN

OBJECT: BOMB, PRACTICE, 100 LB. M 39

INSTRUMENTS: CAMERAS OBSCURAE



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ABSTRACT:

Range bombing was conducted for the 100 lb practice bomb M 39 to obtain experimental data forming the basis for bombing tables BT-100-A-1. A total of seventy ranges for nominal altitudes between 4000 and 15,000 feet with true airspeed varying between 119.6 mph and 197.9 mph, with the largest proportion of air speeds in the neighborhood of 160 mph, was obtained. The results are summarized, tabulated and discussed. The bombing tables BT-100-A-1 for the M 39, 100 lb practice bomb were computed on the basis of C-2.06, and the values of the trail were obtained by employment of the Beckman trail curves for values C near 2.06 and interpolation. The DS was taken to have negligible variation with air speed and was obtained for an airspeed of 160 mph.

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